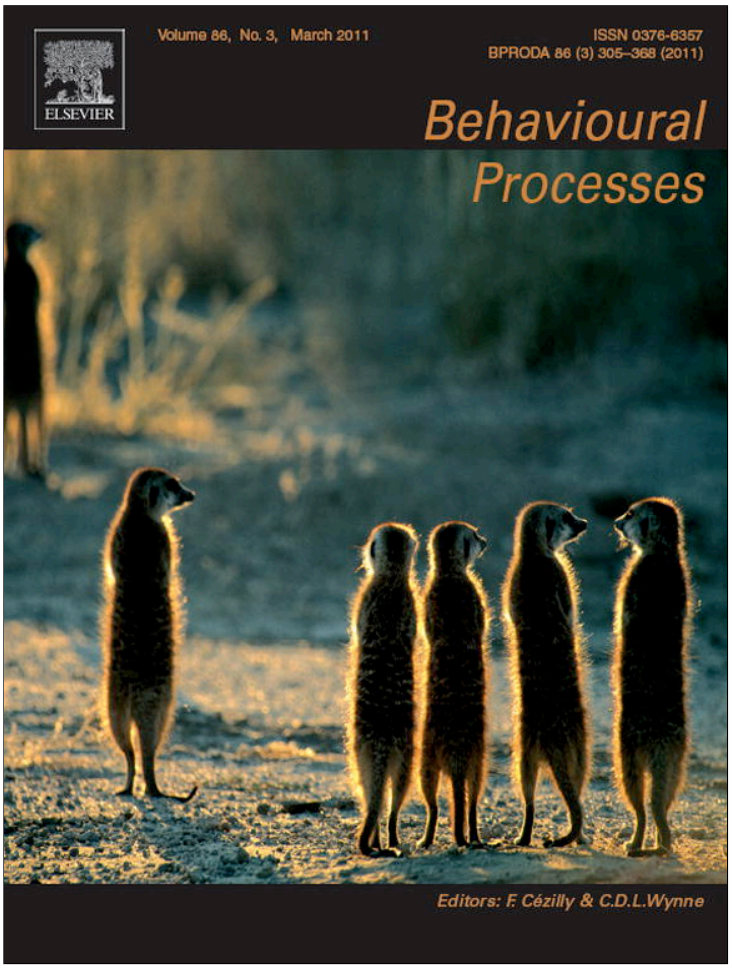

Behavioural Processes 86 (2011) 329–339

Contents lists available at ScienceDirect

Behavioural Processes

journal homepage: www.elsevier.com/locate/behavproc

Using differential reinforcement to improve equine welfare: Shaping appropriate truck loading and feet handling☆

Charlotte Slater, Simon Dymond*

Department of Psychology, Swansea University, Singleton Park, Swansea, SA2 8PP, United Kingdom

ARTICLE INFO

Article history:
Received 14 September 2010
Received in revised form 3 December 2010
Accepted 1 February 2011

Keywords:
Positive reinforcement
Differential reinforcement
Shaping
Autoshaping
sign tracking
Common handling
Multiple baseline
Changing criterion
Horses

ABSTRACT

Inappropriate behavior during common handling procedures with horses is often subject to aversive treatment. The present study replicated and extended previous findings using differential reinforcement to shape appropriate equine handling behavior. In Study 1, a multiple baseline across subjects design was used with four horses to determine first the effects of shaping target-touch responses and then successive approximations of full truck loading under continuous and intermittent schedules of reinforcement. Full loading responses were shaped and maintained in all four horses and occurrences of inappropriate behaviors reduced to zero. Generalization of the loading response was also observed to both a novel trainer and trailer. In Study 2, a changing criterion design was used to increase the duration of feet handling with one horse. The horse's responding reached the terminal duration criterion of 1 min and showed consistent generalization and one-week maintenance. Overall, the results of both studies support the use of applied equine training systems based on positive reinforcement for increasing appropriate behavior during common handling procedures.

In the United Kingdom, an estimated 185,000 horses are kept for hunting, farming, sport or pleasure (Food and Agriculture Organization of the United Nations, 2007). Horses are often expected to emit a wide variety of responses specific to their domestic purpose and living conditions (McCall, 1990), while certain activities are required of nearly all domestic horses. For instance, at least once in a horse's life, it is likely to be transported for veterinary reasons, breeding, sport, rehoming or slaughter (Cross et al., 2008). Due to the small size and elevated, enclosed nature of transport vehicles, a horse that emits inappropriate behaviors and does not easily load can pose a significant risk to itself and its handlers (Ferguson and Rosales-Ruiz, 2001; Houpt, 1982; Waran et al., 2007). Moreover, the unnatural wear that domestic conditions exert on a horse's hoof may require additional intervention in the form of trimming, shaping and shoeing of the foot to maintain optimal health (Wilson, 2007). Farriery requires that horses allow their feet to be held above the ground by a handler, who will have their head in close proximity to the raised foot. Inappropriate behaviors can often lead to farriers receiving injuries (Thompson and Von Hollen, 1996). Overcoming these challenges to equine health is both an important animal welfare and applied research objective.

Both traditional and modern techniques for overcoming problematic equine behavior tend to involve Pavlovian habituation or operant negative reinforcement (McGreevy and McLean, 2007). Habituation occurs when there is a decrease in responding as a result of the repeated presentation of a stimulus that elicits the response (Peeke and Petrinovich, 1984; Thompson and Spencer, 1966). Habituation may be disrupted by the occurrence of ongoing behavior such that the horse shows sensitization and learns negatively reinforced escape or avoidance behaviors. Negative reinforcement, which occurs when a response that terminates or avoids an aversive stimulus increases in frequency, is also widely employed in the equine training literature. For instance, when teaching horses to load or addressing pre-existing loading problems, the use of aversive stimulation is commonly advocated (Lyons, 1991; Parelli, 1993; Roberts, 2007). Roberts' (2007) "Dually" head-collar, for example, is designed to exert pressure at various points of sensitivity across the horse's head when it pulls away from the handler. Subsequent compliance and approach responses are therefore negatively reinforced as they result in the termination of this pressure. Dyson and Carson (2002) suggest wrapping a long rope around the hindquarters of non-compliant horses when attempting to load, or prodding the horse with the bristles of a broom, in order to exert pressure from behind. Any subsequent approaches toward the trailer are nega-

☆ This research was conducted in partial fulfillment of the first author's requirements for a Masters' degree (behavior analysis) under the supervision of the second author. Material from this article was presented at the Annual Convention of the Association for Behavior Analysis International, San Antonio, Texas, May 2010.

* Corresponding author at: Department of Psychology, Swansea University, Singleton Park, SA2 8PP, United Kingdom. Tel.: +44 1792 295602; fax: +44 1792 295679.
E-mail address: s.o.dymond@swansea.ac.uk (S. Dymond).

0376-6357/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.beproc.2011.02.001

tively reinforced as they result in the removal of these aversive stimuli.

Negatively reinforcing forward motion by removing a painful pressure stimulus may be effective when it can be arranged immediately and consistently. However, a number of other potentially dangerous avoidance behaviors, such as rearing or bolting that are not conducive to loading, may also lead to the termination of pressure. A less able trainer may find it difficult to prevent undesirable avoidance behavior and, thus, negatively reinforce the incorrect behavior and exacerbate subsequent loading difficulties. In addition, a gradual increase in aversive stimulation is likely to lead to habituation to the aversive stimulus and a reduction in responding (Cooper et al., 2007; Hall et al., 2008), rendering the techniques ineffective and potentially leading to abuse of the animal (McGreevy and McLean, 2007). Overall, the aversive treatment of problematic behavior, such as truck loading, may lead to undesirable side effects and may be ineffective in overcoming common problems. It is essential, therefore, that non-aversive methods be developed that optimize the learning capacity of horses and have the potential for ease of implementation and dissemination to a wider audience.

Appropriate handling can only be achieved by the systematic manipulation of relevant environmental variables that exert control over behavior, without recourse to aversive methods. One factor responsible for the acquisition of both natural and domestic equine behavior is positive reinforcement (Catania, 1998). Research has shown that the application of positive reinforcement is associated with an increase in explorative equine trial and error responses (Innes and McBride, 2008). Experimentally, equine response rates closely match the relative frequency of positive reinforcement available (Dougherty and Lewis, 1992), and several studies have reported the efficacy of positive reinforcement in teaching discrete responses (Fiske and Potter, 1979; Flannery, 1997; Sappington and Goldman, 1994; Williams et al., 2004). In a comparison study of positive and negative reinforcement training methods for neglected horses, Innes and McBride (2008) found those exposed to schedules of positive reinforcement were more likely to emit the target responses and subsequently received more frequent reinforcement. This led to an observed increase in motivation to participate in rehabilitation activities. These findings have potential for the alleviation of problem behavior by applying positive reinforcement during common handling procedures.

When dealing with problematic behavior, positive reinforcement can be differentially applied to alternative behaviors or behaviors that are incompatible with the undesired response. Desired responding can therefore be increased and undesired behavior reduced, without the need to provide any direct treatment of the problematic behavior itself (Cooper et al., 2007). Differential positive reinforcement techniques include shaping, which is the systematic application of positive reinforcement to successive approximations of a terminal (goal) behavior (Cooper et al., 2007). Shaping was shown to be effective in a study with five problem-loader horses by Ferguson and Rosales-Ruiz (2001) who utilized "clicker training" methods by pairing the sound of a clicker with food presentation approximately 20–30 times over 2 days (Pryor, 1985; Williams et al., 2004). This ensured that the sound of the clicker functioned as a conditioned reinforcer. Next, horses were trained to touch a target placed 0.3–0.6 m in front of the horse's nose. When the horse was touching it consistently, the target was moved to various locations within a loading trailer. Horses were trained to fully load by differentially reinforcing approximations of the terminal loading behavior using 8 successive shaping steps. The 8 steps were previously identified by observing a non-problem loader and ranged from 1 = *approach trailer beyond 10 ft*, 4 = *front legs in trailer*, and 8 = *loaded*. Target training and shaping were effective in training all five horses to load without the use of punishment or negative reinforcement. Moreover, loading responses generalized to novel trailers and trainers, and all horses showed a reduction in the number of problematic behaviors during the intervention.

In Study 1, we systematically replicated the program developed by Ferguson and Rosales-Ruiz (2001) to train four horses to load into a purpose-built transport truck. Generalization to novel trailers and trainers and maintenance of the treatment gains under conditions of intermittent reinforcement were also investigated. In Study 2, the effectiveness of clicker training for increasing the duration of feet handling, an important prerequisite for successful farriery treatment, was further evaluated with one of the horses that displayed the problematic behavior.

1. Method: Study 1

1.1. Subjects

Five gelded male horses identified by their owners as "problematic loaders" were recruited. "Phantom" was a 13 year-old, 16.2 hands Polish Warmblood, "Declan" was an 18 year-old, 16.2 hands Irish Draught × Thoroughbred, "Melon" was a 14 year-old, 15.2 hands British Thoroughbred, "Domino" was a 17 year-old, 15.3 hands Welsh Cob, and "Troy" was a 5 year-old, 16.0 hands Welsh Cob. Horses were included if baseline observations verified owners' reports of problematic loading. On this basis, Melon was excluded from the study as he twice reached the terminal criterion of full loading. Each of the four remaining horses (Phantom, Declan, Domino, and Troy) had been trailer- and truck-loaded in the past, but only following repeated attempts with the use of aversive methods such as shouting, clapping, tightening of ropes around the rear quarters, and whipping. In addition, Troy had been struck from behind with a large plastic tube during previous loading attempts.

1.2. Setting and materials

Throughout the study, horses were 'living out' together in a field with continuous access to grass on the property of a local, private livery yard. No additional daily feeds were arranged and horses were not subjected to any food-deprivation procedures.

Pairing and target training sessions were conducted in a 60 m × 20 m ménage with wooden post and rail fences and an all-weather surface consisting of a sand and rubber mix. Horses were trained individually, while the others remained in a field out of sight and within audible range of the training sessions. Baseline and truck training sessions were conducted in the livery yard car park, which was typically where the horses had previously been loaded.

A two-horse purpose-designed transporting truck, 2.48 m × 2.07 m × 2.21 m, was used for baseline and training sessions. Horses were loaded and off-loaded via a ramp at the rear of the truck; the layout required the horses to turn sideways once inside to position at right angles to the direction of travel. Swinging wooden partition boards separated the 2 areas in which horses would be situated. The ramp was 2.38 m long with a step-up of 20 cm required from the ground to the base of the ramp, and a 17 cm step-up required from the ramp to the interior of the truck. The ramp lay at an angle of 20° from the floor and rose to 81.28 cm from the ground. Five, 5 cm raised wooden bars were affixed horizontally to the floor of the ramp to prevent slipping. During the second generalization sessions, the truck was removed from the car park and replaced by a smaller 2-stall horse transport trailer, with internal dimensions of 1.85 m × 0.80 m × 2.17 m per stall. The trailer was positioned in the same location where the training truck had been, and remained fixed to a stationary car throughout each session. The trailer design required that horses remain front facing once loaded.

Table 1
The 12-step task analysis for complete loading, determined from observations of a reliably loading horse.

1.	Approach to within 3 m of the base of the ramp (where the ramp meets the ground).
2.	Approach to the base of the ramp.
3.	Step up one foot onto ramp.
4.	Step up front two feet onto ramp.
5.	Step up three feet onto ramp.
6.	Step up all four feet onto ramp.
7.	Step up one foot into lorry.
8.	Step up front two feet into lorry.
9.	Step up three feet into lorry.
10.	Step up all four feet into lorry.
11.	Turns sideways into travelling position.
12.	Stands in travelling position long enough for partition board to be latched into place (10 s).

A standard clicker was used that delivered two audible, near-simultaneous clicks. The target comprised a red oven-glove tied to a 120 cm bamboo stake. Potential food reinforcers consisting of a mix of small pieces of carrot, apple, parsnips and plain biscuits that were chosen as a result of each owner's recommendations were stored in an over-shoulder bag worn by the trainer. Each horse wore a cotton head-collar during all sessions. Additionally, Phantom wore a UV-reflective sunburn protection rug and neckpiece, as weather conditions dictated. The video camera was positioned 15 m from the truck and provided a full view of the approach to the ramp and the vehicle's interior.

1.3. Design

A multiple baseline across horses design was used to measure the effects of prompting approach and loading responses using a targeting technique and a shaping intervention with unconditioned and conditioned differential positive reinforcement (Bailey and Burch, 2002; Cooper et al., 2007; Kennedy, 2005).

1.4. Dependent variables and measurement

During baseline, training and generalization phases, two dependent variables were measured; the numbers of task analysis steps completed, and the number and type of any inappropriate behavior emitted. Prior to the commencement of the study, a reliably loading horse was observed in order to determine a task analysis of the chain of behaviors required to complete a successful load (see Table 1). Each trial was conducted with a handler walking beside the horse and holding a lead rope attached to the horse's head-collar. The handler did not apply any pressure to the horse's head at any time. This observation identified a 12-step task analysis (Table 1) to be used in the intervention.

Inappropriate behaviors were defined as; *Head-tossing* (the horse thrust its head upwards and away from the direction of travel); *Standing* (the horse stopped moving with all four feet and did not resume walking when prompted by the handler continuing to walk for two steps); *Turning* (the horse moved its body so that it was no longer facing straight towards the truck); and, *Backing up* (the horse walked backwards for at least one step). The first author served as the trainer and used a measuring tape and markers to determine approach distances from the truck ramp and a stopwatch to record response latency.

1.5. Procedure

1.5.1. Baseline

For each baseline session, the horses were individually led from their field to the livery yard. From a starting distance of 7 m, each horse was directed towards the truck by the trainer, who walked beside the horse and did not place any pressure on the lead rope or attempt to pull or drag the horse. If the horse stopped walking, the trainer continued to walk for two further steps. This was repeated every time the horse stopped. After stopping, horses were given 5 s to begin walking again. If the horse followed the trainer into the truck, it was recorded as a full independent load. If at any point the horse stopped for more than 5 s and did not follow the trainer toward the truck, the trial ended and the horse was prompted to take 3–5 steps back by the handler placing light pressure on the animal's chest to ensure they were a safe distance from the truck ramp before being turned and lead back to the field. Trials were also terminated immediately following the occurrence of any inappropriate behaviors. Baseline sessions consisted of one trial and were conducted daily for each horse.

Table 2
The six different locations of the target during target training, and the sequence in which the responses were trained (from 1 to 6).

1.	Target held 30 cm–60 cm from nose, directly in front of horse.
2.	Target held 30 cm–60 cm from nose, in all directions.
3.	Target placed on floor in front of horse.
4.	Target held at distance requiring one step to make contact.
5.	Target held at distance requiring two steps to make contact.
6.	Target held at various positions around ménage; horse follows target.

1.5.2. Pairing

Pairing began following the third baseline session for all horses. A single clicker sound was simultaneously paired with pieces of preferred food presented to each horse. Pairing trials were repeated 30 times per day for two days (Ferguson and Rosales-Ruiz, 2001), with inter-trial intervals ranging from ten to thirty seconds, dependent upon the speed with which the horse consumed each piece of food. Successful pairing was verified by the efficacy of the click stimulus at shaping approach responses during target training. Had these novel responses not emerged during the first target training session the horse would have been returned to the pairing condition for an additional day.

1.5.3. Target training

Target training commenced within two to four hours following completion of the final pairing session. The target was presented to the horse to initiate trials and was hidden from view between trials. A click, followed by a piece of food, was delivered each time the horse touched its nose to the target. If the horse did not make contact with the target during the presentation, the target was removed from view and no reinforcement was provided. Initially, the target was presented for 10 s to increase the likelihood that the horse would make contact with it through explorative responses. Once the horse had contacted reinforcement three times at this level, the time of target presentation was reduced to 5 s to promote fluent responding. Prompted trials occurred if the horse did not initiate contact with the target on the first two presentations, and involved the target being touched against the horse's nose while a click was delivered. If the horse backed away, it was held with a lead rope and head-collar to allow the handler to prompt. Initially the target was held between 30 cm and 60 cm directly in front of the horse's nose. When the horse responded correctly at this level within 5 s of target presentation, for three consecutive trials, the response was considered mastered and the next target distance was trained. Table 2 lists the six target distances that were presented during target training, which required differentiated response effort. If the horse did not make contact with the target for two consecutive trials, it was re-presented at a previous mastered step until responding was regained over two trials. Twenty trials were conducted per session; however, two sessions were extended to 22 trials to ensure that they were terminated

following an independent targeting response and reinforcement delivery.

The terminal criteria for target training required that the horses respond correctly within 5 s across a minimum of 90% of the trials per session (at least 50% of which had to involve responding at response level six) across two consecutive sessions. When horses achieved these criteria, they commenced truck training.

1.5.4. Truck-training

Once the first horse met the target-training criteria, he began truck-training sessions. Initially, the target was placed at a distance that required the horse to perform the minimum number of steps of the task analysis completed during baseline in order to establish responding at an achievable level. Each trial involved the presentation of the target, a response from the horse and either reinforcement following a correct response or no reinforcement following either an incorrect or no response. Following either incorrect or no responses, the horse was led away from the truck to a distance of 7 m before a new trial began. Following correct responses, a click was delivered immediately after the horse touched the target with its nose and was followed by delivery of a piece of preferred food. Correct responses were defined as the horse approaching and touching the target within 10 s of its presentation. Responses were allocated 5 s more than the terminal criteria for a correct touch response during target training, as the response effort required during truck training was greater, necessitating that the horses stepped up onto the ramp and walked in an uphill motion. If the horse correctly touched the target within 10 s on three consecutive trials, the target was placed 30 cm further toward the terminal position within the truck on the next trial. If the horse responded incorrectly by emitting an incompatible behavior (head-tossing, standing, turning or backing up), or emitted no approach response within 10 s, for two consecutive trials, the target was moved 30 cm back away from the terminal position on the next trial.

Had any horse continued not to respond when the target had been moved three meters away from the ramp, they would have been returned to target training sessions. If at any point the horse walked past the target and further into the truck than the current criterion level required, the target was moved to the position at which the horse came to a stop, allowing the response of touching the target to still be performed and reinforcement delivered. On the trial following such a response, the target was moved 30 cm further into the truck than its original position on the previous trial. A maximum of ten trials were conducted in each experimental session. When the horse reached the terminal criterion on the first and second trial of a session, the session ended.

Once a horse had achieved step 10 of the task analysis (putting all four feet inside the truck; see Table 1) for two consecutive sessions, truck training was introduced for the next horse, as per the requirements of the multiple baseline design, providing they had met the target training terminal criteria and their baseline responding was stable. The terminal criterion for truck training required that horses were fully loading for at least 90% of trials across two consecutive sessions.

1.5.5. Reinforcer maintenance

Each horse completed a reinforcer maintenance session on reaching the truck-training criterion. During these maintenance sessions, food was delivered following, on average, every two correct trials (i.e., a variable ratio (VR) 2 schedule), while the clicker sound was presented following every correct response emitted within 10 s (i.e., continuous conditioned reinforcement schedule). A total of eight trials were conducted during these maintenance sessions.

1.5.6. Generalization

Following maintenance, two generalization probes were conducted in sequence for each horse. For the first probe, each horse's owner attempted to load his or her horse into the truck. The original trainer stood with the target at the terminal position within the truck and delivered the reinforcement upon successful completion of the task. For the second generalization probe, the trainer presented horses with a horse trailer, smaller than the truck that was used for training initially. As the trailer design required that horses remain facing forward once loaded, the criterion for reinforcement required the horses stand long enough for a rear chain to be latched behind them.

1.5.7. Social validity/treatment acceptability

Following completion of the second generalization probe, each owner was provided with a questionnaire designed to assess the acceptability of the aims, implementation and results of the study. Six questions addressed the owner's experiences of loading their horse prior to, and after truck training, in terms of the frequency and intensity of loading difficulties and how stressful loading was for their horse. The seventh question assessed the acceptability of the time taken to complete the truck training and three questions related to the likelihood that the owners would implement the training techniques themselves and whether they would recommend them. The questionnaire required the owners to rate each question using a five-point Likert scale, where 1 = *every time*, 2 = *very often*, 3 = *sometimes*, 4 = *not often*, and 5 = *never*.

1.6. Procedural and data integrity

1.6.1. Interobserver agreement

A total of 36% ($n = 8$) of target training sessions and 33.3% ($n = 36$) of baseline and truck training sessions were observed by an independent rater who had extensive experience of collecting experimental data and had received detailed information regarding the target behavior definitions and training procedures. Interobserver agreement scores were calculated by dividing the number of agreements by the sum of agreements and disagreements and multiplying by 100%. Interobserver agreement scores were 98.3% for target training; 99.2% for the number of task analysis steps completed across the rated baseline and training sessions, and 99.3% for the frequency of inappropriate behaviors observed during these sessions.

The independent rater also recorded treatment integrity scores on the accurate implementation of the independent variable for 36% ($n = 8$) of target training sessions and 22.2% ($n = 24$) of truck training sessions. In addition, during 11.1% ($n = 12$) of truck training sessions, reliability of the delivery of food was calculated by comparing the number of food pieces present before and after the session. Treatment integrity scores were determined by dividing the number of clicks or food pieces delivered by the number of opportunities for reinforcement, per session. The reliability with which both the clicks and food were delivered following a correct response was 100% across all sessions. When calculating the integrity of food delivery, sessions that were conducted under the VR2 schedule were not included because the number of opportunities for reinforcement was reduced by an average of two. For the treatment integrity check on these sessions, the number of correct responses was divided by the total number of food pieces delivered. It was found that reinforcement on the VR2 schedule had been arranged following an average of 2.1 correct responses.

2. Results and discussion

Each of the four horses learned to touch the target in the first target training session. Fig. 1 shows the percentage of tri-

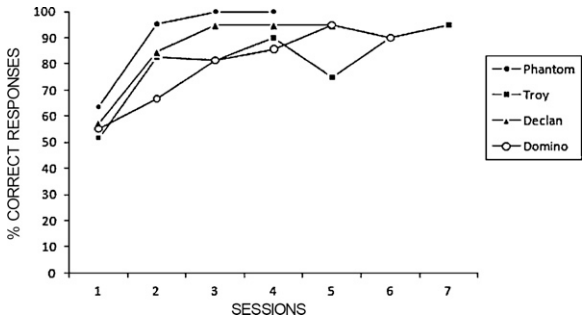

Fig. 1. Target training: The percentage of trials that each horse emitted the correct response within 5 s of target presentation.

als per session in which each horse correctly responded to the presentation of the target within 5 s. Phantom reached the terminal criterion first, requiring four target training sessions. Declan, Domino and Troy reached criterion after five, six and seven target training sessions, respectively. These data demonstrate that the clicks and food served as reinforcers during target training, as their contingent delivery led to the development of novel approach behaviors under specific stimulus control of the target, for each horse.

Fig. 2 shows the maximum number of steps of the task analysis completed by each horse in each session of truck training. During baseline, responding ranged from 0 to 3 steps completed, with the exception of Declan's first session in which he reached step 6 (i.e., getting all four feet onto the truck ramp). Phantom was the first horse to begin truck training, and during his first session he immediately began placing his front two feet on the ramp, a response that he had not emitted before. Phantom required a further two sessions to learn to fully enter the truck and remain there for 10 s with the interior partition closed. All four horses met this terminal criterion: Troy and Declan after 9 training sessions, and Domino after 14 sessions.

Full loading responses (i.e., all steps of the task analysis completed) were maintained in all four horses when food delivery followed, on average, every second response (i.e., VR2). During the first generalization session, Phantom, Declan and Domino's trained loading responses fully generalized to the novel handlers. Troy, on the other hand, did not go further than placing all four feet on the ramp when handled by his owner. In the second generalization session, all four horses fully loaded onto a transport trailer, which was smaller and different in design to the truck used in training.

Fig. 3 shows the frequency of head tossing, standing, turning and backing up behaviors displayed by each horse emitted during baseline and truck training. With the exception of Phantom, who did not display any backing up behavior, all horses emitted all of these responses at varying levels throughout baseline, with head tossing being the most frequently observed. Immediately following the introduction of truck training conditions for each horse, the level of turning responses dropped to zero. All other responses also dropped in frequency and remained at a lower level during this phase. By the time the horses were loading fully, the frequency of all incompatible responses had dropped to zero levels, where they remained during the maintenance and generalization sessions. During the first generalization session, Troy was the only horse to emit incompatible behaviors (standing three times and head tossing once).

The social validity measures confirmed that the owners had experienced difficulty when loading their horses prior to the study. Three owners had rated loading as "very difficult" or "difficult" (Phantom). Three owners also stated that these difficulties arose "every time" they attempted loading, with Domino's owner rating the frequency as "very often". On completion of the study, Troy and Phantom's owners rated loading as "very easy" and Domino and Declan's owner found it "easy". Three owners reported the frequency of loading difficulties post-study as "never", with one owner stating a reduction to "not often". All four horses had been reported as finding truck training either "stressful" or "very stressful" before training began; all four owners reported their horse's experience as either "not very stressful" or "not at all stressful" post-study. The overall acceptability of the aims and results of the study were high and all owners considered the program to be completed either "quickly" or "very quickly". Each owner felt able to continue using the techniques employed and reported that they would be "very likely' to use the techniques to train other horses and would "definitely" recommend the procedure.

In summary, all four horses were trained to fully load into a purpose built transport truck, using target training and shaping with food and clicker training reinforcement. All incompatible behaviors reduced to zero without the experimenter needing to specifically target their reduction. All of the horses demonstrated clear generalization to a novel, smaller trailer, and three of the four horses' loading responses also generalized to a novel handler. Overall, the results of Study 1 are consistent with those reported by Ferguson and Rosales-Ruiz (2001), and further support the notion that full loading can be achieved through the systematic application of differential positive reinforcement and without the use of aversive stimulation. Furthermore, the present study showed that it was possible to generalize this full loading behavior to both a novel vehicle and handler, and that such responding could be maintained with an intermittent schedule of reinforcement.

3. Method: Study 2

Following the successful shaping of appropriate loading behaviors in Study 1, Troy was selected for participation in a further study to increase the duration of time he allowed his feet to be held by a handler. For 3 years prior to the study, Troy received bimonthly foot trimming from a farrier but was unable to have shoes fitted due to the inappropriate behavior he emitted while having his feet handled. In Study 2, we used a changing criterion design to increase the duration of feet handling with Troy.

3.1. Subject and setting

Troy participated in Study 2. Feet training sessions were conducted on a yard within a covered, open sided barn adjacent to the car park used during Study 1. One trainer (the first author) was present with the horse during all sessions, which were videotaped.

3.2. Design

A changing criterion design with an initial baseline phase was implemented, in which the target duration of response, measured in seconds, was systematically increased until a pre-determined level of responding was reached (Cooper et al., 2007; Hartmann and Hall, 1976; Kennedy, 2005). Occurrences of inappropriate behaviors were also recorded. Sessions were conducted twice daily.

3.3. Dependent variables and measurement

Two dependent variables were measured during baseline, training, generalization and maintenance phases. First, the duration of time that the horse's foot was held, from the moment the hoof of the lifted leg was positioned horizontally in the handler's hand until either 1 min had passed or the horse emitted inappropriate

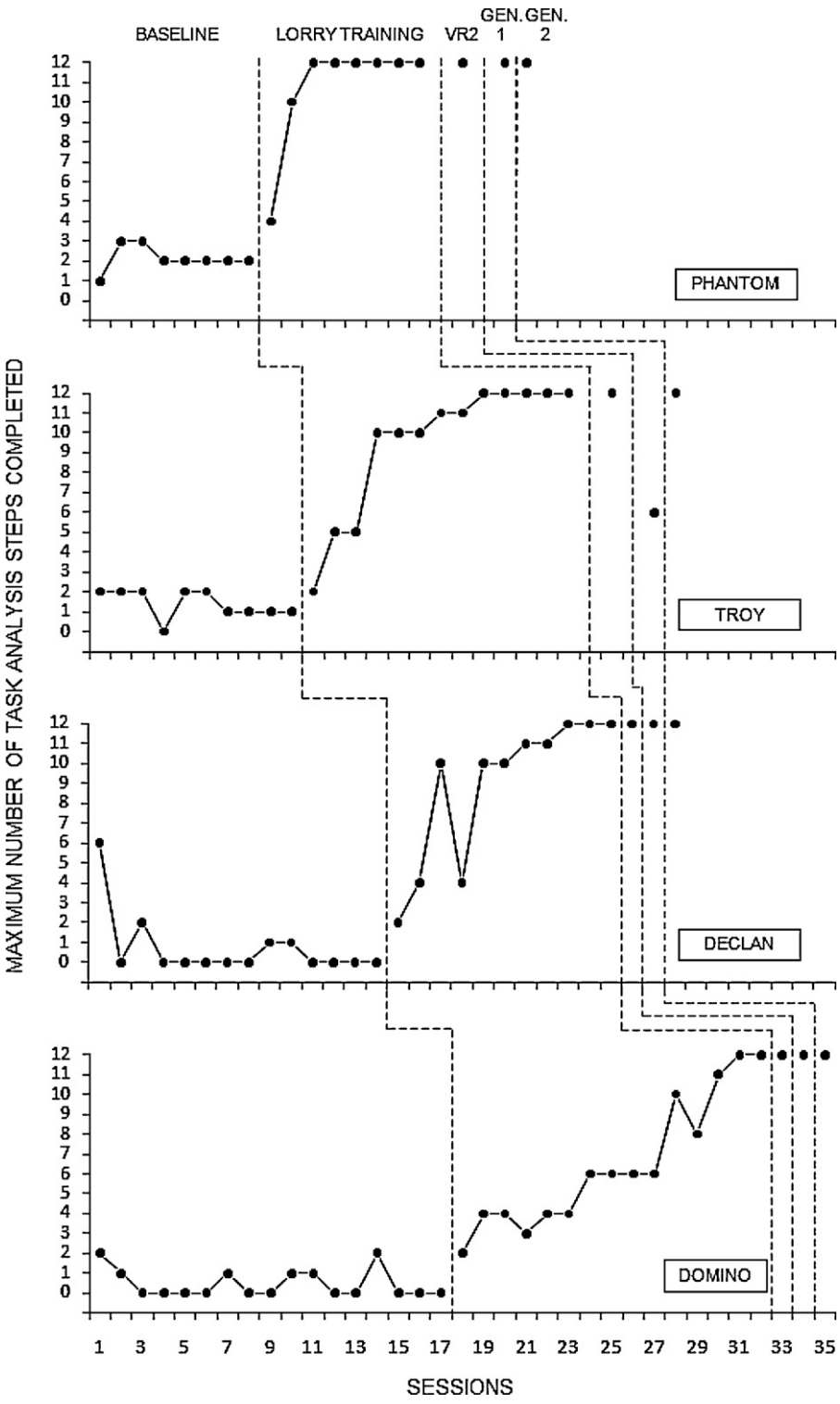

Fig. 2. The number of task analysis steps completed during each shaping session. Note: "VR2" refers to the schedule of food reinforcement available contingent upon the delivery of conditioned reinforcement, "Gen 1" refers to generalization sessions with the horses' owners as handlers, and "Gen 2" refers to generalization sessions conducted with a novel trailer.

behavior. If inappropriate behavior was emitted before the handler was able to position the hoof in the start position, a time of 0 s was recorded for that trial. During all sessions, the trainer wore a stopwatch. Second, the number of occurrences of the following inappropriate behaviors were recorded; *Leaning*, defined as the horse exerting pressure on the leg being held and into the trainer's hand; *stamping*, defined as when the horse forced its foot out of the trainer's hand and on to the ground; *straightened leg* involved the horse straightening its leg at the knee and forcing the foot either forwards if front leg or backwards if hind leg; *pawing* consisted of the horse moving the bent leg backwards and forwards from the shoulder, and, finally, *lifting another foot*, defined as the horse raising any of its other feet off the ground.

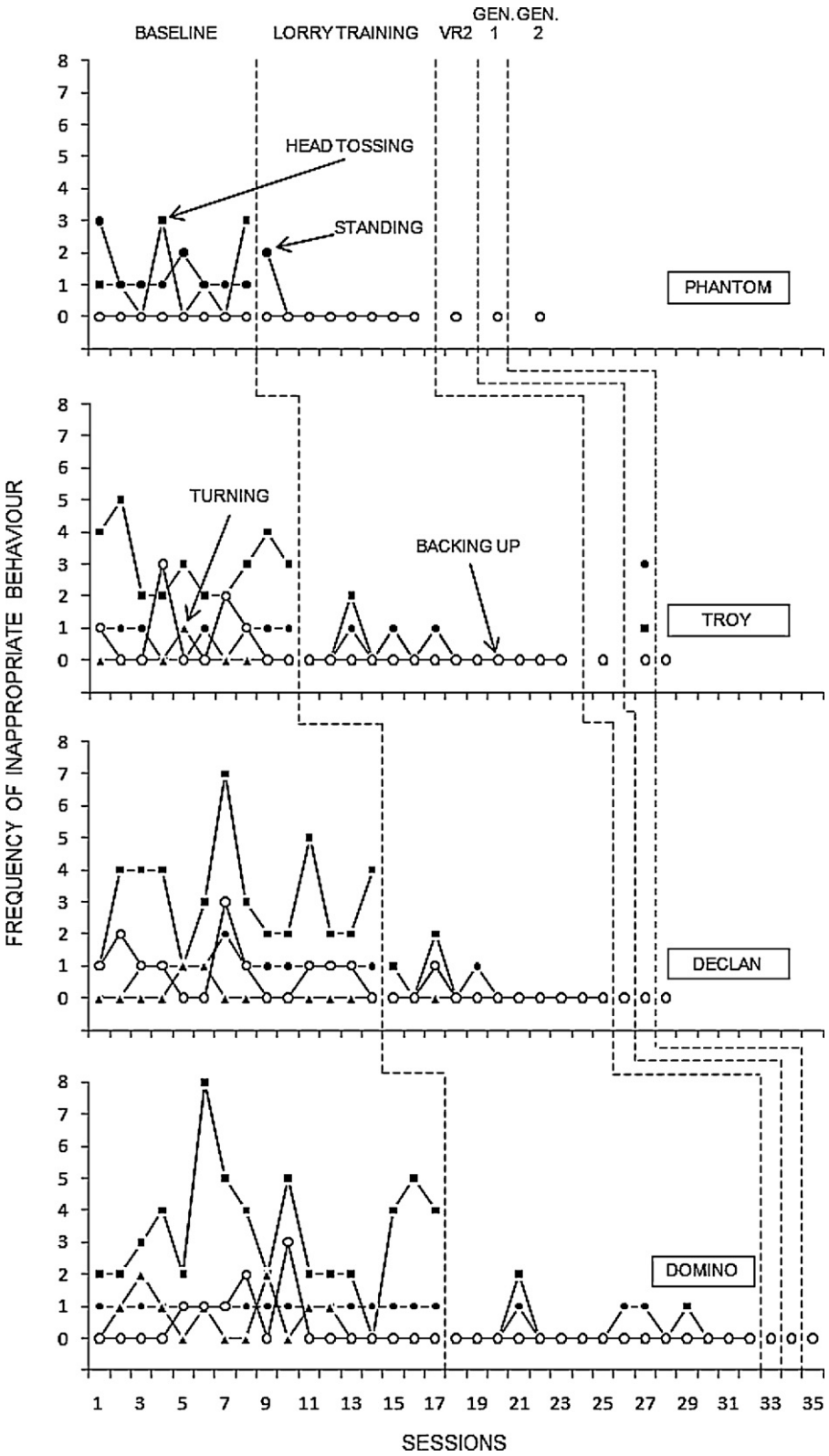

Fig. 3. The number and type of inappropriate behaviors emitted by each horse per session. Note: "VR2" refers to the schedule of food reinforcement available contingent upon the delivery of conditioned reinforcement, "Gen 1" refers to generalization sessions with the horses' owners as handlers, and "Gen 2" refers to generalization sessions conducted with a novel trailer.

3.4. Procedure

3.4.1. Baseline

In each baseline session, responding was observed over eight trials, consisting of two trials for each of Troy's feet. When lifting each foot, the trainer stood directly to the side of the horse's leg and faced the opposite direction to the horse. Starting at the shoulder on the front legs, and the stifle for the hind legs, the trainer ran the hand closest to the horse down the front of its leg to the foot and then gripped the hoof and attempted to lift it upwards. Once

off the ground, the foot was lifted and the horse's leg bent at the knee while the front wall of the hoof rested horizontally in the trainer's hand, at which point timing of the response commenced. Trials were terminated after 1 min or following the occurrence of inappropriate behavior.

3.4.2. Feet training

Eight trials were conducted per session, consisting of two trials per foot. On every trial, Troy was first prompted to lift his foot as in baseline. The shortest duration that he had allowed his feet to be held up during baseline was selected as the first target duration. A click sound was delivered on a schedule of continuous reinforcement, contingent upon Troy allowing his foot to be held for specified duration. Clicks were followed by a piece of food on a VR2 schedule. When the response duration met the first target criterion level for at least 80% of trials across two consecutive sessions, the target duration was increased by 5 s. Subsequent levels were increased in 10 s increments. Following an increase at any level, if after two sessions responding had not met the new target duration for at least one trial (and Troy had, therefore, not contacted any reinforcement) the target duration was reduced by 5 s. Training continued until Troy maintained the target response for 1 min, over at least 87.5% of trials per session (i.e., 7/8), for two consecutive sessions.

3.4.3. Generalization

On achieving the terminal criterion, Troy's owner replaced the trainer to test whether the lifting and duration responses would generalize to a novel handler. If Troy held his feet appropriately for 1 min, the trainer, who remained present during the sessions, delivered the clicks following every correct response and food on a VR2 schedule. The generalization session consisted of two trials for each of Troy's feet (i.e., a total of 8 trials).

3.4.4. Maintenance

One week following completion of the feet training and generalization sessions, Troy's owner conducted a maintenance session. During the intervening period of time, Troy had not had his feet held. Reinforcement for correct responses was contingent on a response duration of 1 min; clicks were delivered following every correct response and food on a VR2 schedule

3.4.5. Social validity/treatment acceptability

Following completion of the generalization probe, Troy's owner was provided with a social validity questionnaire, similar to that issued in Study 1. By choosing one of five possible responses for each question, the owner rated the frequency and intensity of problems experienced when holding Troy's feet up, prior to and after the study. The acceptability of the foot training, in terms of the duration and replicability of the intervention, was also assessed.

3.5. Procedural and data integrity

3.5.1. Interobserver agreement

An independent rater scored the number of inappropriate behaviors emitted in 33.3% ($n = 8$) sessions across the baseline and training phases, as well as whether or not the criterion duration had been met in each trial over 33.3% ($n = 8$) of training sessions. Agreements between the rater and experimental data were divided by the sum of agreements and disagreements and multiplied by 100%; inter-observer agreement was 100% for measures of both dependent variables.

For 33.3% ($n = 8$) of training sessions, the rater also recorded the number of times a click and a piece of food had been delivered following a correct response. The number of opportunities for click reinforcement was divided by the number of clicks delivered and multiplied by 100%, which gave a treatment integrity score of 100%. Food delivery was programmed on a VR2 schedule; the actual schedule of delivery was calculated by dividing the number of correct responses by the number of food pieces delivered, as recorded by the independent rater. An average of 2.3 responses resulted in food reinforcement.

4. Results and discussion

Fig. 4 (upper panel) illustrates Troy's responding during baseline and intervention. Shown is the mean duration of feet-holding, as well as the maximum duration of response recorded per session. During baseline, Troy only allowed his feet to be held for a maximum of 10 s for one trial across four baseline sessions. The mean duration during baseline was 4.59 s. During the intervention, duration of foot holding consistently adapted to the increasing criteria levels and reached the terminal criterion in the 17th session. This high level of responding was maintained in the presence of a novel handler (Troy's owner) immediately following training and at one-week follow up.

Fig. 4 (lower panel) shows the frequency of inappropriate behavior during baseline and intervention. Under baseline conditions, inappropriate behaviors were emitted at varying levels in all trials, with stamping being most frequent and pawing least frequent. During the intervention, the level of all inappropriate responses dropped markedly; there were two peaks of responding in sessions 10 and 13, although these did not match the high level of inappropriate responding observed during baseline. Once responding occurred at the final criterion level, the occurrence of inappropriate responses had reduced to zero. Only one occurrence of leaning was emitted during the generalization and maintenance sessions. Despite this, the maximum duration of foot holding generalized to Troy's owner for more than 80% of trials in both the generalization and maintenance sessions.

Troy's owner reported that holding her horse's feet up had been "very difficult" "every time" prior to the study, and that Troy had found the procedure "very stressful". Following completion of feet training, the same dimensions were rated as "easy", "not often" and "not very stressful". The owner considered the training completed "very quickly" and reported that she would feel "very able" to replicate the procedure used and "very likely" to do so with other horses in the future. Troy's owner also stated that she would "definitely" recommend the procedure.

In summary, the results of Study 2 demonstrated that conditioned positive reinforcement was effective in increasing the duration of feet handling in a horse that had previously shown resistance to such treatment. A reduction in occurrence of incompatible behaviors during common feet handling procedures was also observed. The time that Troy allowed his feet to be held increased in duration from 5 s to 60 s across the course of the intervention, and treatment effects generalized from the researcher to his owner and were maintained one week later. The findings of Study 2 provide, for the first time, experimental evidence in support of Lethbridge's (2009) reports that clicker training may be used to shape precursor behaviors to farriery.

5. General discussion

In Study 1, differential positive reinforcement resulted in all four horses fully loading and continuing to load in the presence of a novel trailer and a novel trainer, and under conditions of intermittent reinforcement. In Study 2, duration of feet handling was increased. Together, the findings demonstrate the effective application of differential reinforcement to increase appropriate handling behavior and decrease inappropriate behavior in horses, without recourse to aversive methods.

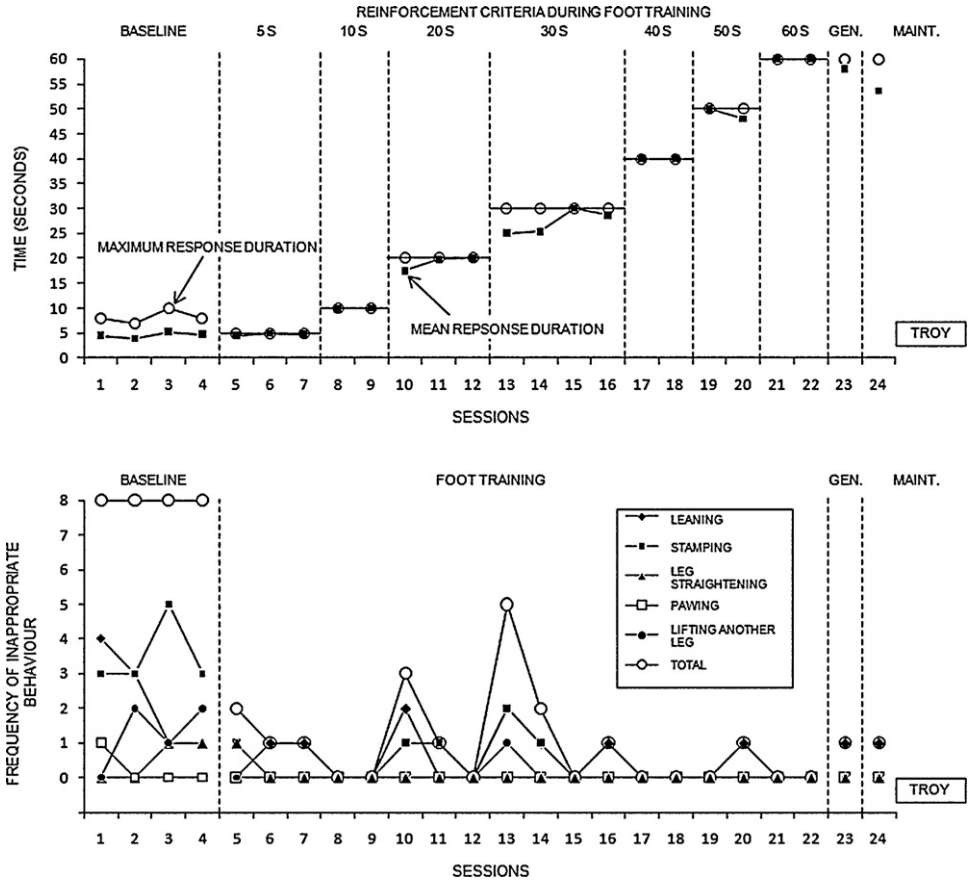

Fig. 4. Upper panel: duration (in seconds) for each session that Troy allowed his feet to be held up by the trainer in Study 2. Horizontal lines show the reinforcement criteria during training, clear circled data points show the maximum duration, filled circled data points indicate the sessions where the maximum duration occurred for a minimum of 80% of trials, unfilled circles show the maximum duration that occurred for less than 80% of trials, and the mean response durations per session are indicate by square data points. Lower panel: the frequency and types of inappropriate behaviors emitted per session during baseline, training, generalization and maintenance phases.

The present findings are supportive of an explanation in terms of *autoshaping* or *sign tracking* (Brown and Jenkins, 1968; Burns and Domjan, 2000; Leslie et al., 1979). In Pavlovian appetitive conditioning, autoshaping occurs following CS-US presentations when approach responses are made to the CS even though doing so does not affect US presentation. In the present study, horses approached and followed the target (CS) into the truck, while incompatible behavior unrelated to food delivery decreased. It may be argued that the addition of differential reinforcement for successive approximations towards the target may have served to facilitate sign tracking still further. The present procedures, then, likely harnessed the combined influence of operant and Pavlovian processes in facilitating appropriate loading responding and reducing inappropriate behavior.

The handling behaviors shaped during both studies showed generality (Stokes and Baer, 1977) to novel handlers and a novel transport vehicle in truck training. Several aspects of the environment remained constant from training to generalization environments, which is likely to have facilitated this effect (Stokes and Baer, 1977). First, in Study 1, in addition to the original truck and the novel trailer being parked in the same location in the car park, the same experimenter also handled the horses when presenting the novel trailer, which meant that the specific movements of the handler were present across both the training and novel environments. This resembles a strategy of promoting generalized behavior change described by Stokes and Baer (1977), called *programming common stimuli*, in which typical features of the generalization setting are incorporated into the training setting. It is likely that this strategy, although unintended, accounted for the generalization seen in the present study. Future studies on equine loading may seek to systematically investigate the strategy of programming common stimuli when training horses to load into trailers, which are characteristically smaller than lorries and is often more problematic than truck loading (Ferguson and Rosales-Ruiz, 2001).

Second, during both studies, the presence of the experimenter may have become discriminative for the availability of positive reinforcement, unlike the owner who is likely to have become discriminative for/associated with loading methods based on aversive control. Troy's inappropriate avoidance behaviors may also have had a history of being negatively reinforced in the presence of the owner, making them more likely to occur in her presence in the future. It is possible that Troy's history of exposure to aversive stimuli may have interfered with the reinforcement available during the owner-handler generalization session (Dougherty and Lewis, 1992). Future research should therefore consider having the owner conduct the procedure from the outset.

Third, in order to increase the likelihood of generalization, multiple exemplars should be trained (Stokes and Baer, 1977). This would entail the systematic application of reinforcement to approximations of the terminal response across different locations and handlers. Furthermore, during training in Study 1, the horses were not dressed in travelling boots and blankets, as they would be if required to travel once loaded. To reduce the possibility of these stimuli evoking the undesired behavior, comprehensive loading should involve this equipment at an early stage of training.

Finally, the thinned schedule of reinforcement did not adversely affect terminal behavior in Study 1 and was sufficient to facilitate the shaping of desired responding behavior throughout Study

2. Intermittent schedules of reinforcement increase behavioral resistance to extinction as some responses, but not others, are reinforced (Catania, 1998; Cooper et al., 2007). In the present studies, once appropriate levels of behavior were established, thinning the schedule of reinforcement may have further increased the resistance to extinction of the shaped behaviors because intermittent schedules are less distinguishable from extinction than schedules of continuous reinforcement (Catania, 1998; Cooper et al., 2007; Pryor, 1985). The present VR2 schedule was sufficient to compete with avoidance behaviors in foot training and establish new behaviors, but future investigations are well advised to examine the effects of further thinning the schedules. By reducing the necessity for the trainer to have large quantities of food present, implementation of the procedures would be both less effortful and at reduced risk of 'treatment drift' (Peterson et al., 1982).

Alternative explanations of the present findings are possible. Some researchers have argued that providing reinforcement for behaviors that are incompatible with undesired responses may be termed 'counter conditioning' (Christensen et al., 2006). Christensen and colleagues found that counter conditioning was less effective than both habituation and systematic desensitization at decreasing fear-like responses in horses. During counter conditioning, Christensen et al. (2006) relied on horses naturally accessing reinforcement while performing the desired response (eating from a bucket). Unlike the present study, successive approximations of this behavior were not reinforced. Instead, the researchers merely arranged the environment in order to make the behavior more likely to occur (e.g., placing a food bucket within reach). Moreover, given this arrangement it was possible for a horse, having taken a mouthful of food from the bucket, to then emit an undesirable behavior while eating, and thus contact reinforcement. Such adventitious pairing of reinforcement with inappropriate behavior may have resulted in an increase in those behaviors. Conversely, the present study involved reinforcing successive approach responses (Study 1) and increasing response duration (Study 2) in a systematic manner that negated incompatible, problematic behaviors when reinforcement was systematically applied during targeted, discrete learning trials.

A second alternative process, 'systematic desensitization' (Gough, 1999), may have contributed to the reduction of inappropriate responding. In Study 1, the horses may have gradually become desensitized to the presence of the truck due to its continual presence. In Study 2, Troy's reactions to having his feet handled may have been reduced in the same way. However, there are several possible reasons why such an explanation is incomplete. First, in Study 1, horses also learned to emit targeting responses and to actually approach the truck, which would not have occurred on the basis of desensitization alone. If approach behaviors had not been shaped in Study 1, the horses' avoidant behaviors may have prevented them being sufficiently close to the truck to become desensitized. Second, even if desensitization *had* come to influence behavior, it would have become evident in the baseline rates of responding. Finally, the levels of responding observed in Study 2 conformed very closely to the available schedule of reinforcement, which was unlikely to occur had the horse become desensitized to the handling procedure rather than receiving reinforcement specifically for compliant responding.

There are several advantages to the present horse-training regime based on differential positive reinforcement. First, the horses' environments were enriched by the training procedures, which provided them with access to positive reinforcement for discrete, achievable tasks (Laule and Desmond, 1998; Tarou and Bashaw, 2007). This is likely to have differed from their previous experiences of being handled where "treats" were not necessarily delivered following a clearly specified approximation or response, if at all. Second, the implementation of training gave horses more control over their environment and 'communicated' clear ways in which the horse could manifest its own rewards. As desirable results were quickly obtained, it is likely that any handler using these techniques would have their own behavior quickly reinforced, and thus both animal and owner would find training enjoyable and enriching. Training by positive reinforcement may well yield better relationships within the horse–human dyad than methods derived from negative reinforcement that rely on the application of aversive stimuli (Sankey et al., 2010). Third, shaping equine behavior with positive reinforcement is a safer method of addressing potentially risky procedures such as loading and handling horses' feet than either punishment or negative reinforcement. With appropriate use of reinforcement, shaping should quickly promote desired, targeted behavior, whereas negative reinforcement results in the horse emitting the correct response through chance, having potentially already trialed a series of unrelated or dangerous escape behaviors. Finally, anecdotal observations suggested that the training procedures produced several 'collateral' or respondent behaviors. For instance, all four horses approached the field gate when they saw the experimenter, and waited while each horse was taken, and returned to, the field (Ferguson and Rosales-Ruiz, 2001). Also, while being led to the yard, the horses were observed to walk next to the experimenter at a quicker pace with their head carriage and ears raised, indicating increased alertness (Mills and Riezebos, 2005). In conclusion, the present findings demonstrate the utility of differential positive reinforcement in designing and evaluating behavioral interventions aimed at improving equine welfare.

Acknowledgements

The authors thank Mrs. A. Snow for permitting the research to be conducted at Birchall Green Farm, Ms. J. Spicer for generously donating the use of her truck, Chris Gillespie for assistance with the figures, the owners for kindly volunteering their horses for training, and Jennifer L. Austin, Jesús Rosales-Ruiz, and an anonymous reviewer for helpful comments on a previous version of this article.

References

Bailey, J.S., Burch, M.R., 2002. Research Methods in Applied Behavior Analysis. Sage, London.
Brown, P.L., Jenkins, H.M., 1968. Autoshaping of the pigeon's keypeck. J. Exp. Anal. Behav. 11, 1–8.
Burns, M., Domjan, M., 2000. Sign tracking in domesticated quail with one trial a day: generality across CS and US parameters. Anim. Learn. and Beh. 28, 109–119.
Catania, A.C., 1998. Learning, third ed. New Jersey, Prentice Hall.
Cooper, J.O., Heron, T.E., Heward, W.L., 2007. Applied Behavior Analysis, second ed. Prentice Hall Inc., New Jersey.
Christensen, J.W., Rundgren, M., Olsson, K., 2006. Training methods for horses: habituation to a frightening stimulus. Equine Vet. J. 38, 439–443.
Cross, N., Versnel, C., Cawdell-Smith, J., Phillips, C., 2008. Effects of lighting conditions on the welfare of horses being loaded for transportation. J. Vet. Beh. 3, 20–24.
Dougherty, D.M., Lewis, P., 1992. Matching by horses on several concurrent variable-interval schedules. Behav. Process. 26, 69–76.
Dyson, S., Carson, D.M., 2002. Behavioral problems. In: Hayes, M.H. (Ed.), Veterinary Notes for Horse Owners. Simon and Schuster, New York, pp. 673–684.
Ferguson, D.L., Rosales-Ruiz, J., 2001. Loading the problem loader: the effects of target training and shaping on trailer-loading behavior of horses. J. Appl. Behav. Anal. 34, 409–424.
Fiske, J.C., Potter, G.D., 1979. Discrimination reversal learning in yearling horses. J. Anim. Sci. 49, 583–588.
Flannery, B., 1997. Relational discrimination learning in horses. Appl. Anim. Behav. Sci. 54, 267–280.
Food Agriculture Organization of the United Nations (FAO), 2007. FAOSTAT On-line Statistical Service, Retrieved from: http://faostat.fao.org/.
Gough, M.R., 1999. A note on the use of behavioral modification to aid clipping ponies. App. Anim. Beh. Sci. 63, 171–175.
Hall, C., Goodwin, D., Heleski, C., Randle, H., Waran, N., 2008. Is there evidence of learned helplessness in horses? J. Appl. Anim. Welf. Sci. 11, 249–266.
Hartmann, D.P., Hall, R.V., 1976. The changing criterion design. J. Appl. Behav. Anal. 9, 527–532.

Houpt, K., 1982. Misbehavior of horses: trailer problems. Equine Practice 4, 12–16.
Innes, L., McBride, S., 2008. Negative versus positive reinforcement: an evaluation of training strategies for rehabilitated horses. Appl. Anim. Behav. Sci. 112, 357–368.
Kennedy, C.H., 2005. Single Case Designs for Educational Research. Merrill, London.
Laule, G., Desmond, T., 1998. Positive reinforcement training as an enrichment strategy. In: Shepherdson, D.J., Mellen, J.D., Hutchins, M. (Eds.), Second Nature: Environmental Enrichment for Captive Animals. Smithsonian Institution Press, Washington, pp. 302–313.
Lethbridge, E., 2009. Knowing your Horse: A Guide to Equine Learning, Training and Behavior. Blackwell, London.
Leslie, J.C., Boakes, R.A., Linaza, J., Ridgers, A., 1979. Autoshaping using visual stimuli in the rat. Psychol. Rec. 29, 523–546.
Lyons, J., 1991. Lyons on Horses. Doubleday, New York.
McCall, C.A., 1990. A review of learning behavior in horses and its application in horse training. J. Anim. Sci. 68, 75–81.
McGreevy, P.D., McLean, A.N., 2007. Roles of learning theory and ethology in equitation. J. Vet. Behav.: Clin. Appl. Res. 2, 108–118.
Mills, D.S., Riezebos, M., 2005. The role of the image of a conspecific in the regulation of stereotypic head movements in the horse. Appl. Anim. Behav. Sci. 91, 155–165.
Parelli, P., 1993. Natural Horsemanship? Colorado Springs, Western Horseman.
Peeke, H.V.S., Petrinovich, L. (Eds.), 1984. Habituation, Sensitization, and Behavior. Academic Press, Orlando.
Peterson, L., Homer, A.L., Wonderlich, S.A., 1982. The integrity of independent variables in behavior analysis. J. Appl. Behav. Anal. 15, 477–492.
Pryor, K., 1985. Don't Shoot the Dog! The New Art of Teaching and Training. Bantam, New York.
Roberts, M., 2007. Ask Monty: The 150 Most Common Horse Problems Solved. Headline, London.
Sankey, C., Richard-Yris, M.A., Leroy, H., Henry, S., Hausberger, M., 2010. Positive interactions lead to lasting positive memories in horses, Equus caballus. Anim. Behav. 79, 869–875.
Sappington, B.F., Goldman, L., 1994. Discrimination learning and concept formation in the Arabian horse. J. Anim. Sci. 12, 3080–3087.
Stokes, T.F., Baer, D.M., 1977. An implicit technology of generalization. J. Appl. Behav. Anal. 10, 349–367.
Tarou, L.R., Bashaw, M.J., 2007. Maximizing the effectiveness of environmental enrichment: suggestions from the experimental analysis of behavior. Appl. Anim. Behav. Sci. 102, 189–204.
Thompson, R.F., Spencer, W.A., 1966. Habituation: a model phenomenon for the study of neuronal substrates of behavior. Psychol. Rev. 73, 16–43.
Thompson, J.M., Von Hollen, B., 1996. Causes of horse-related injuries in a rural western community. Can. Famil. Physic. 42, 1103–1109.
Waran, N., Leadon, D., Friend, T., 2007. The effects of transportation on the welfare of horses. In: Waran, N. (Ed.), The Welfare of Horses. Springer, Netherlands, pp. 125–150.
Williams, J.L., Friend, T.H., Nevill, C.H., Archer, G., 2004. The efficacy of a secondary reinforcer (clicker) during acquisition and extinction of an operant task in horses. Appl. Anim. Behav. Sci. 88, 331–341.
Wilson, R.T., 2007. Specific welfare problems associated with working horses. In: Waran, N. (Ed.), The Welfare of Horses. Springer, Netherlands, pp. 203–218.